CONCORDIA
UNIVERSITY

MECHANICAL ENGINEERING
AT
CONCORDIA

SIR GEORGE WILLIAMS CAMPUS
HALL BUILDING,
1455 DE MAISONNEUVE BLVD. WEST
MONTREAL, QUEBEC H3G 1M8

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MECHANICAL ENGINEERING AS A CAREER

The Mechanical Engineer is concerned with the creation of devices, systems, structures and processes for human use as well as applying scientific, mathematical, economic and social knowledge to satisfy specific needs of the community. The services required of mechanical engineers encompass a very wide range of professional activity, such as design, research, development and management carried out in environments of equally diverse nature, such as industry, medicine, private practice, university and government.

Mechanical Engineering is perhaps the most diversified of the traditional engineering disciplines and has made possible many of the technological advances of present times. Representative fields of endeavour for mechanical engineers include all forms of power generating equipment (steam, internal combustion, nuclear, jet, rocket, fuel cells) and their operation and maintenance, the design of mechanisms and machines, controls and automation, vibration analysis, energy studies and environmental control (heating, ventilation and refrigeration), materials handling and precision instrumentation.

Mechanical Engineering is an extremely broad field and is a combination of ideas, imagination, creativity, experience, testing, analysis, and synthesis. Any of the specific fields of practice may involve design: a process of testing experimental as well as development to determine performance; research: creating solutions to new problems through analysis and design of processes and products; development: transformation of research into a specific product; operation and maintenance: regular inspection and corrective actions for trouble-free and efficient performance; marketing: sales, installation, and servicing of products or systems; management and administration: project planning, supervision, policy and decision making.

JOB OPPORTUNITIES

Training in Mechanical Engineering and professional practice in this field are both very interesting, satisfying and rewarding experiences. The job opportunities are many in primary and secondary industries, government agencies, in teaching or even in private practice and are as diverse as the many thousands of products created by Mechanical Engineers.

In his/her first job after graduation, the typical engineer will usually spend some time learning details of the job, which could not be included in an undergraduate programme. Some employers help this process by organizing in-house training. After this initial period the young engineer begins to assume more and more responsibilities.

The type of function assigned to a Mechanical Engineer depends on many factors such as ability to conceive new ideas, ease in dealing with mathematical concepts, ability to organize, etc. Success, however, as in any other profession, depends on ambition, motivation and continuing study habits.

MECHANICAL ENGINEERING AT CONCORDIA

PREFACE

The Department of Mechanical Engineering at Concordia offers one of the best learning experiences in engineering education available on this continent. Its professors have gained world-wide recognition for their activities in both research and engineering practice and have developed a curriculum with the relevance and depth needed for today's technological society, at the same time maintaining close contact with their students.

PROGRAMME

In view of the very wide range of activities in the field, the mechanical engineering curriculum consists of a combination of core courses with a series of technical electives. Strong emphasis is given to building on the principles presented in the basic engineering and physical systems courses of the General Requirements. Further core courses are taken by all mechanical engineering undergraduates, and deal with topics basic to the field, including control theory, thermodynamics, fluid mechanics, heat trasnfer, machine design and metallurgy.

The mechanical engineering curriculum is particularly strong in design content and the courses in this area are taught generally by a team of faculty members with expertise in different aspects of mechanical engineering design and industrial consulting. Leading off with a sequence of required courses in engineering drawing, a series of core courses, Machine Drawing and Design, Mechanical Engineering Design and Mechanical Engineering Laboratory I and II, with possible open electives such as Design or Experimental Project, give sufficient depth in design skills needed for mechanical engineering graduates. Projects given in these courses stress creative approach and often lead to manufacture of actual prototypes for evaluation through testing and a final project report to be presented and defended by the students orally in class. A scheme for obtaining interesting projects from industry for distribution to students is also in effect. Some projects also evolve through the requirements of research programs currently undertaken by faculty members. Every year Concordia student projects have been chosen for the national finals of the CSME Student Design Competition. The students also participate in the SAE Mini Baja Vehicle Competition with a creditable showing.

Technical and non-technical electives form the main component of the curriculum in the final two years in mechanical engineering. Technical electives allow students to obtain some specialization in a particular area of the field, depending on their interests and expected future professional activity. Four general areas of specialization are available, as follows:

OPTION A Thermo-Fluid and Propulsion

The core and elective courses recommended for this option prepare the students for careers in aerospace, power generation, energy transfer and control, environment, and fluids engineering fields. Specific opportunities include design, analysis, research, development, marketing and maintenance of gas turbines, jet and rocket engines, other internal combustion power plants, heat exchangers, solar power generation, heating, ventilating and air conditioning, hydraulic power, and nuclear engineering systems. Courses available for this option include Heat Transfer, Turbomachinery, Gas Dynamics, Aerodynamics, Gas Turbine Design, Materials Engineering, Microprocessors, etc.

OPTION B Design and Production

The core and elective courses in this option prepare the students for careers in machinery design, manufacturing, production, and materials engineering fields. Specific opportunities include design, analysis, research, development, and maintenance of equipment such as production machinery, service machines, power transmission devices, and mechanisms. Reliability, product quality, materials handling, stress and vibration engineering are also covered. Courses offered include Mechanical Shaping of Metals, Comuter-Aided Mechanical Design, Machine Design, Vibrations, Electric Machinery, Operations Research, Optimization, Computer Organization and Software, etc.

OPTION C Automation and Control Systems

The core and elective courses in this option provide the students with fundamentals and methodology including state-of-the-art in design and analysis of mechanical and hybrid control systems, process control equipment, servomechanisms, feedback systems, and fluid power devices. Specific area of concentration include industrial automation, simulation, computer-aided controls and microprocessor applications. Courses available inlcude Control System Design, Fluid Power Control, Microprocessors, System Optimiation, Vibrations, Process Dynamics and Control, etc.

OPTION D Industrial Engineering

This unique option program of core and elective courses provides the students with a basic knowledge of economy, finance, management, production planning and project engineering areas built on a solid mechanical engineering base program. Career opportunities include manufacturing and production engineering, quality control and maintenance, industrial management, project planning and development, human factor engineering, safety engineering, and optimal strategies for efficiency and cost saving in industry. The option is designed to provide the necessary background to define and solve problems related to the conception, improvement, and implementation of integrated industrial systems involving people, materials, and money. Courses in this option include Advanced Probability, Human Factor Engineering, Industrial Economics, Production Engineering, Operations Research, Organizational Management, Finance, Microprocessors, Industrial Engineering Project and Seminar, etc.

The contents of the elective courses are constantly updated to include recent technical developments in the area and the choice pattern is evaluated to provide maximum benefit to students in reflecting their professional interests. All elective options and sequence of courses must be approved by the Chairman of the Department or his representative.

Non-technical aspects of the program are accommodated through required courses in engineering law and economy, technical literature, and two compulsory courses chosen from a set of social aspects of engineering courses dealing with the broader implications of engineering and technology on the individual, society and environment.

ACCREDITATION OF PROGRAMME

The programme is accredited by the Accreditation Board of the Canadian Council of Professional Engineers and by the Order of Engineers of Quebec.

FACULTY AND STAFF

The Mechanical Engineering Faculty comprises 9 Professors, 8 Associate Professors, 4 Assistant Professors, several Visiting and Adjunct Professors, Research Associates and Lecturers. They are engaged in industrial as well as theoretical research and development; many have gained an international reputation. There is considerable cooperation and interaction with industry. To further this cooperation a few specialist courses are taught by practicing engineers and a number of faculty members act as consultants to industry. The main research groups and their typical projects in the Mechanical Engineering Department are listed on pages 13 to 18.

LOCATION

The Mechanical Programme can be completed on the Sir George Williams Campus. The first year of the programme is simultaneously offered on the Loyola Campus.

LABORATORIES

Laboratory work supports the classroom lectures and is essential in developing an understanding of engineering principles and applications.

Lab manuals have been written by the faculty which describe in detail the experiments to be carried out. These are made available to the student at the start of the year.

The following is a summary of the major laboratories:

1) Thermodynamics Laboratory
2) Fluid Mechanics and Heat Transfer Laboratory
3) Kinematics and Dynamics Laboratory
4) Vibration and Shock Testing Laboratory
5) Machine Tool Laboratory
6) Fluid Power Laboratory with 100 hp Hydraulic Test Installation
7) Measuring Laboratory with Talysurf and Talyrand Surface Texture Measuring Systems
8) Fluid Control Research Laboratory
9) Control Systems and Automation Laboratory
10) Materials Laboratory
11) Solar Energy Laboratory
12) Instrumentation and Measurements Laboratory
13) Computer Aided Design and Graphics Laboratory

SUPPORTING FACILITIES

1) A well equipped precision Machine Shop staffed by 7 full-time machinists.

2) Central CDC CYBER 835 time sharing computer. A separate pamphlet describing the hardware and sortware is availabe from the Computer Center.

3) Hybrid computer lab with an EAI 690 system staffed by a full-time simulation engineer and a technical assistant.

4) A dedicated VAX 11/780 computer with 512KB of core memory, two cartridge disk curves (28 MB each), and an additional Winchester disk drive of 675 MB; a Kennedy 800/1600 BPI magnetic tape drive and a NORPAK/VDP high performance, raster scan color video graphic system; a CALCOMP model 1012, 12" drum plotter; a tektronix model 4663, flat bed plotter; and several CRT's, micros, etc.

STUDENT PROJECTS

Throughout the Programme projects are assigned to enable the student to apply the theories learned and to gain practical experience. In some courses students undertake projects on their own initiative. A few project titles follow:

1) Recycled Car Project.
2) Design of a Solar Heating System.
3) Design of a Deep-Hole Boring Machine.
4) Vibration and Noise Analysis in Vehicles.
5) Pneumatic Braking System on Freight Trains.
6) Design of Flight Simulator.
7) Design of Motor Vehicle Shock-Absorbers and Agriculture Tractor Seat Suspension.
8) Development of Light-Weight Composite Materials and Structures.
9) Bioengineering Projects.
10) Reliability Estimation.
11) Coal Conversion.
12) Interactive Graphics - CAD of an Off-Road Motorcycle.

DURATION OF STUDIES

The normal duration of the Mechanical Engineering Programme is eight terms (four years) of full-time study. The programme is very demanding and no part-time jobs should be held during the regular sessions. Students with applicable credits from other institutions may attempt to finish the programme in less than eight terms, the scheduling of courses permitting.

COURSE SCHEDULING

Courses are scheduled for students following the regular programme as outlined on pages 7 to 12. Students missing important prerequisite courses may loose a full year due to the inability to accommodate the required courses without interference.

MECHANICAL ENGINEERING, OPTIONS A,B,C

Year 1 Term 1 Fall	COMP C211 Introduction to Computers & Computing EMAT C212 Calculus and Differential Equations ENGR C212 Technical Drawing ENGR C242 Statics ENGR C273 Basic Circuit Analysis
Year 1 Term 2 Winter	EMAT C232 Matrices & Advanced Calculus ENGR C213 Descriptive Geometry ENGR C243 Dynamics ENGR C251 Thermodynamics I ENGR C274 Physical Systems
Year 2 Term 3 Fall	EMAT C311 Transform Calculus & P. Differential Equations ENGR C221 Material Science ENGR C361 Fluid Mechanics I MECH C313 Machine Drawing & Design MECH C351 Thermodynamics II
Year 2 Term 4 Winter	EMAT C271 Applied Probability & Statistics ENGR C244 Mechanics of Materials ENGR C281 Technical Writing ENGR C362 Fluid Mechanics II MECH C311 Mechanical Engineering Laboratory I
Year 3 Term 5 Fall	ELEC C318 Industrial Electronics MECH C341 Kinematics of Machines MECH C352 Heat Transfer I MECH C411 Mechanical Engineering Laboratory II
Year 3 Term 6 Winter	EMAT C391 Numerical Methods ENGR C372 Fundamentals of Control Systems ENGR C402 Engineering Law ENGR C403 Engineering Economy MECH C321 Strength & Failure of Metals MECH C342 Dynamics of Machines
Summer	ENGR C410 Technical Report
Year 4 Term 7 Fall	ENGR C49x Social Aspects of Engineering MECH C373 Instrumentations & Measurements MECH C441 Mechanical Engineering Design Elective * Elective *
Year 4 Term 8 Winter	ENGR C49x Social Aspects of Engineering Elective * Elective * Elective * Elective *

(*) 5 Electives total. See pages 11,12

MECHANICAL ENGINEERING CURRICULUM

Engineering Core

COMP C211	3	Intro. to Computers & Computing
EMAT C212	3	Calculus & Differential Equations
EMAT C232	3	Matrices & Advanced Calculus
EMAT C271	3	Applied Probability & Statistics
EMAT C391	3	Numerical Methods in Engineering
ENGR C212	2	Technical Drawing
ENGR C273	3.75	Basic Circuit Analysis
ENGR C281	2	Technical Literature
ENGR C402	1.5	Engineering Law
ENGR C410	1.5	Technical Report
HUMANITIES	6	Social Aspects of Engineering
	31.75	Credits

Mechanical Engineering Core

EMAT C311	3	Transform Calculus & P.D. Equations
ELEC C318	3.75	Industrial Electronics
ENGR C213	2	Descriptive Geometry
ENGR C221	2	Materials Science
ENGR C242	3	Statics
ENGR C243	3	Dynamics
ENGR C244	3.75	Mechanics of Materials I
ENGR C251	3	Thermodynamics I
ENGR C274	3.75	Physical Systems & Measurements
ENGR C361	3	Fluid Mechanics I
ENGR C372	3.75	Fundamentals of Control Systems
MECH C311	2.5	Mechanical Enginering Laboratory I
MECH C313	3	Machine Drawing & Design
MECH C321	3	Strength and Failure in Metals
MECH C373	3.75	Instrumentation & Measurements
MECH C411	2.5	Mechanical Engineering Laboratory II
	48.75	Credits

List I, Options A,B & C

ENGR C362	3.75	Fluid Mechanics II
ENGR C403	1.5	Engineering Economy
MECH C341	2.5	Kinematics of Machines
MECH C342	2.5	Dynamics of Machines
MECH C351	3.75	Thermodynamics II
MECH C352	3.75	Heat Transfer I
MECH C441	3	Mechanical Engineering Design
	20.75	Credits

Option A, Thermo Fluid and Propulsion

MECH C452*	3.75	Heat Transfer II
MECH C461*	3.75	Gas Dynamics
MECH C462*	3	Turbomach. & Propulsion
Electives	9	
	16.5	Credits

Option B, Design and Production

MECH C412*	3.75	Computer Aided Design
MECH C421*	3.75	Deformation & Shaping
MECH C445*	3.5	Machine Design
Electives	9	
	16.5	Credits

Option C, Automation & Control Systems

ENGR C473*	3.75	Control Systems Design
MECH C463*	3.75	Fluid Power Control
MECH C471*	3.75	Microprocessors & Appl.
Electives	9	
	16.5	Credits

(*) Option Core: two out of three

List II

Option D, Industrial Engineering

ACCO C213	3	Accountancy I
COEN C411	3.75	Comp. Org. & Software
EMAT C272	3	Adv. Prob. & Statistics
INDU C310	3	Human Factor Engineering
INDU C313	3	Industrial Economics
INDU C320	3	Production Engineering I
INDU C321	3	Production Engineering II
INDU C323	3	Indust. Oper. Research
INDU C330	3	Organiz. Management
INDU C480	3	Indust. Engin. Project
INDU C481	0.5	Indust. Engin. Seminar
Electives	6	
	37.25	Credits

MECHANICAL ENGINEERING, OPTION D, INDUSTRIAL ENGINEERING

Year 1 Term 1 Fall	COMP C211 Introduction to Computers & Computing EMAT C212 Calculus and Differential Equations ENGR C212 Technical Drawing ENGR C242 Statics ENGR C273 Basic Circuit Analysis
Year 1 Term 2 Winter	EMAT C232 Matrices & Advanced Calculus ENGR C213 Descriptive Geometry ENGR C243 Dynamics ENGR C251 Thermodynamics I ENGR C274 Physical Systems
Year 2 Term 3 Fall	EMAT C311 Transform Calculus & P. Differential Equations ENGR C221 Material Science ENGR C361 Fluid Mechanics I INDU C320 Production Engineering I MECH C313 Machine Drawing & Design
Year 2 Term 4 Winter	EMAT C271 Applied Probability & Statistics ENGR C244 Mechanics of Materials ENGR C281 Technical Writing INDU C321 Production Engineering II MECH C311 Mechanical Engineering Laboratory I
Year 3 Term 5 Fall	ACCO C213 Accountancy I ELEC C318 Industrial Electronics EMAT C391 Numerical Methods INDU C323 Industrial Operations Research MECH C411 Mechanical Engineering Laboratory II
Year 3 Term 6 Winter	COEN C411 Computer Organization & Software EMAT C272 Advanced Probability & Statistics ENGR C372 Fundamentals of Control Systems ENGR C402 Engineering Law INDU C313 Industrial Economics MECH C321 Strength & Failure in Metals
Summer	ENGR C410 Technical Report
Year 4 Term 7 Fall	ENGR C49x Social Aspects of Engineering INDU C310 Human Factor Engineering INDU C480 Industrial Engineering Project MECH C373 Instrumentation & Measurements Elective *
Year 4 Term 8 Winter	ENGR C49x Social Aspects of Engineering INDU C330 Organizational Management INDU C481 Industrial Engineering Seminar Elective * Elective *

(*) 2 Electives total. See page 12

ELECTIVES

OPTION A, THERMO FLUID AND PROPULSION

Fall	MECH C461*	Gas Dynamics
	MECH C462*	Turbomachinery & Propulsion
	ENGR C471	Time Domain Analysis & Design
	ENGR C473	Control Systems Design
	MECH C421	Deformation & Shaping of Metals
	MECH C423	Thermal Treatment & Processing
	MECH C443	Mechanical Vibrations
	MECH C481	Design or Experimental Projects
Winter	MECH C452*	Heat Transfer II
	ELEC C334	Electric Machinery
	ENGR C475	Process Dynamics & Control
	MECH C453	Heating, Ventilating & Air Conditioning Systems
	MECH C464	Aerodynamics
	MECH C465	Gas Turbine Design
	MECH C471	Microprocessors & Applications

(*) Option core, two out of three

OPTION B, DESIGN AND PRODUCTION

FALL	MECH C421*	Deformation & Shaping of Metals
	COEN C411	Computer Organization & Softwar
	ENGR C471	Time Domain Analysis & Design
	ENGR C473	Control Systems Design
	INDU C323	Industrial Operations Research
	INDU C420	Mathematics of Optimization
	MECH C423	Thermal Treatment & Processing
	MECH C443	Mechanical Vibrations
Winter	MECH C412*	Computer Aided Mechanical Design
	MECH C445*	Machine Design
	INDU C411	Industrial Applications of Computers
	MECH C453	Heating, Ventilating & Air Conditioning Systems
	MECH C463	Fluid Power Control
	MECH C471	Microprocessors & Applications

(*) Option core, two out of three

FOR OPTIONS C AND D, SEE PAGE 12

ELECTIVES

OPTION C, AUTOMATION & CONTROL SYSTEMS

Fall	ENGR C473*	Control Systems Design
	ENGR C471	Time Domain Analysis
	INDU C323	Industrial Operations Research
	INDU C420	Mathematics of Optimization
	MECH C443	Mechanical Vibrations
	MECH C481	Design or Experimental Projects
Winter	MECH C463*	Fluid Power Control
	MECH C471*	Microprocessors & Applications
	ELEC C334	Electric Machinery
	ENGR C472	Systems Optimizations
	ENGR C475	Process Dynamics & Control
	MECH C453	Heating, Ventilating & Air Conditioning Systems

(*) Option core, two out of three

OPTION D, INDUSTRIAL ENGINEERING

Fall	ENGR C471	Time Domain Analysis & Design
	INDU C410	Safety Engineering
	INDU C420	Mathematics of Optimization
Winter	ELEC C334	Electric Machinery
	INDU C411	Industrial Applications of Computers
	INDU C423	Inventory Control
	MECH C471	Microprocessors & Applications

FOR OPTIONS A AND B, SEE PAGE 11

RESEARCH AREAS IN THE MECHANICAL ENGINEERING DEPARTMENT

MECHANICAL SYSTEMS GROUP

DESCRIPTION: Research work in mechanical systems at Concordia incorporates vibrations, machine tools, system design, mechanisms, noise analysis, preventive maintenance, computer-aided design and composite materials.

SCOPE OF WORK: Research, development, design with emphasis on production machinery and industrial applications.

FACILITIES: Fully instrumented Machine Tool Laboratory; Mechanical Vibration Laboratory with 100 lb shaker system; low frequency, long stroke electro-hydraulic shaker; fully instrumented for noise and vibration analysis and shock testing; Measuring Laboratory with Talysurf 4 and Talyrand 51; Kinematics and Dynamics Laboratory; hybrid computing system with direct link to laboratories; deep-hole machining and hydraulic copying rsearch facilities; digital (CDC CYBER 835) and hybrid computers. Complete 2 channel real time FTT analyzer and modal analysis system with all supporing softwares. Acoustic emission test equipment, MTS fatigue tester, photoelastic polariscopes and strain gage instrumentation.

FACULTY:

M.O.M. Osman, Dr.sc.techn. (Swiss Fed. Institute)	Machine Tool Dynamics, Tribology, Metal Cutting, Mechanisms & Gear, Transmissions.
T.S. Sankar, Ph.D. (Waterloo)	Mechanics, Vibration Problems in Mechanical Systems and Reliability, Biomedical applications.
G.D. Xistris, D.Sc.A. (Université de Montréal)	Machinery Reliability, Noise and vibrations and Signal Processing .
S. Sankar, D.Eng. (Sir George Williams)	Computer-Aided Design, Vehicle Dynamics, Optimization and Vibration Control in System Design.
S.V. Hoa, Ph.D. (Toronto)	Vibration, Stress Analysis, Composite Materials, Finite Element.
A.E. Blach, Ph.D. (Université de Montréal)	Stress Analysis, Pressure Vessels and Piping, Heat Exchanger Design.
R.B. Bhat, Ph.D. (I.I.T., Madras)	Random Vibrations, Rotor Dynamics Structural Acoustics.

TYPICAL PROJECTS: Monitoring and analyzing noise and vibrations of industrial machinery, including thermal and vibratory stresses; preventive maintenance routines; analysis and design of energy absorption devices for critical vibrations in machinery elements; unbalance response in rotating machinery; short-time acceptance tests for machine tools; evaluation of surface roughness of manufactured components and its influence on properties such as fatigue, bearing strength, lubricability, etc.; off-road vehicle seat suspension; active and semi-active suspension; motorcycle shock absorbers; CAD of complex mechanical systems through interactive graphics and Finite Element analysis; composite materials applications; fiberglass reinforced plastic pressure vessels; high damping composite materials; pressure vessel and piping stress analysis.

INDUSTRIAL CONTROL SYSTEMS

DESCRIPTION: Industrial Control Systems incorporate pneumatics, fluidics, hydraulics, electronics and control engineering.

SCOPE OF WORK: Research, development, design and simulation with emphasis on sensing, measurement, automation and control applications in industry; low-cost automation with emphasis on production operation, mechanical transfer and handling; special purpose industrial "robots"; application of control theory and computer methods to the design and analysis of industrial control systems; computer-aided design interactive simulation.

FACILITIES: Well equipped research laboratory; experienced staff with design and prototype capability; low-cost automation laboratory open to industry contains about 30 working circuits of typical industrial applications to demonstrate the advantages and potential of new technology; digital and hybrid computer facilities.

FACULTY:

C.Kwok, Ph.D. (McGill)	Pneumatic and Fluidic Systems, Fluid Dynamics and Design.
R.M.H. Cheng, Ph.D. (Birmingham)	Design and Analysis of Automation and Control Systems.
J. Svoboda, D.Eng. (Concordia)	Fluid Controls, Hydraulic Systems and Flight Simulators.
T. Krepec, D.T.Sc. (Warsaw)	Fuel Control Systems, Internal Combustion Engines.
Y. Stepanenko, Ph.D. (Moscow)	Robotics.

TYPICAL PROJECTS: Light aircraft flight simulation; non-contact position sensing; optimization of valve design; electro-hydraulic servoactuators for flight controls; study and modeling of transient flow and automization of fuel in the supply system for gas turbine engines, diesel engines and spark ignition engines with fuel injection; design and modification of fuel control units with mechanical, hydraulic, penumatic and electronic governing systems, particularly for the use of alternate fuels; development of test rigs with physical simulators for testing of fuel control systems in steady state and transient conditions.

THERMO-FLUID POWER AND PROPULSION

DESCRIPTION: Research encompasses experimental, analytical and computational work in combustion, solar energy, heat transfer, aerodynamics of turbomachinery.

SCOPE OF WORK: Development of modern computational techniques for the analysis of gas dynamic and transonic aerodynamic phenomena, especially in gas turbines; analysis and testing of phase-change, heat transfer processes; design and testing of solar heating and cooling systems; numerical methods in unsteady compressible flow; analysis of implosions, explosions and stability of moving shock waves.

FACILITIES: Wind Tunnels, Fluid Dynamics Laboratory; Thermodynamics Laboratory; Heat Transfer Laboratory; Solar Research Laboratory; Heat Pump Laboratory; Digital Computer and Terminal facilities, CDC CYBER 835; Combustion Laboratory; Shock Wave Dynamics Laboratory and associated instrumentations.

FACULTY:

W.G. Habashi, Ph.D. (Cornell)	Finite Element Application in Aerodynamics, Computational Methods in Turbomachinery.
K.I. Krakow, M.S. (Caltech)	Environmental Control, Solar Energy.
S. Lin, D-Ing. (Karlsruhe)	Solar Energy, Heat and Mass Transfer Processes.
R.A. Neemeh, Ph.D. (McGill)	Shock Wave Dynamics and Related Phenomena, Unsteady Wave Motion in Compressible Flow.
A.J. Saber, Ph.D. (Princeton)	Study of Experimental Methods Coal Gasification, Rocket Motor Instabilities.

TYPICAL PROJECTS: Finite element computational study of aerodynamic flows at high subsonic and transonic Mach numbers; study of acoustic and structural phenomena in solid propellant rocket motors; resonance phenomena and their application; numerical methods in aerodynamics of turbomachines; air and solar source heat pumps; heat and mass transfer in porous media; energy transfer in confined vortex flows; ignition of gaseous mixtures by shock waves; testing of supersonic flow in compressor cascades; plasma dynamics.

MATERIALS IN MANUFACTURING

DESCRIPTION: Hot working of metals encompasses the microstructural changes taking place inside the metals; the ductility and strength of various alloys; the simulation of multistage rolling and forging and the product properties. Mechanical behavior of fiber reinforced plastic composites; fatigue, fracture, creep and effect of environments; analysis using finite element method.

FACILITIES: Compression and torsion tests by means of microprocessor controlled equipment; optical and electron microscopy. Composite materials fabrication equipment; MTS fatigue testing machine, environmental chamber, photoelastic polariscope.

FACULTY:

H.J. McQueen, Ph.D. (Notre Dame)	Hot Working of Metals, Energy Conversion in Manufacturing, Energy Strategy, Solar Materials
S.V. Hoa, Ph.D. (Toronto)	Composite Materials, Stress Analysis, Dynamics.

TYPICAL PROJECTS: Simulation of a hot reversing mill with up-coil furnaces; measurement and flow stress during passes and of softening between passes for both carbon steels and new high strength low-alloy steels. Fatigue and fracture of sheet molding components; fatigue and fracture of graphite/epoxy composites; effect of stress concentration on fracture strength of composite under uniaxial and biaxial loadings; effect of water absorption on the mechanical behavior of SMC and of graphite/epoxy composites; design methodology.

INDUSTRIAL ENGINEERING AND RELIABILITY IN SYSTEMS

DESCRIPTION: Research involves (i) development of efficient computational techniques for solving industrial engineering problems; (ii) modeling and performance evaluation of large industrial systems and (iii) reliability problems in systems.

SCOPE OF WORK: (i) Design, mathematical analysis and experimental evaluation of graph and discrete optimization algorithms for problems arising in industrial applications. These problems include: scheduling and sequencing of jobs, network reliability analysis, vehicle routing such as the travelling salesman problem, circuit layout, etc.... (ii) Studies in queuing networks and queuing network modeling of large systems such as computer systems. (iii) Investigation of reliability of mechanical systems using direct and indirect methods.

FACULTY:		
	K. Thulasiraman, Ph.D. (I.I.T., Madras)	Graph Theory, Discrete Optimization and Algorithms, Networks and Systems Theory.
	T.S. Sankar, Ph.D. (Waterloo)	Reliability Analysis and Mechanical Systems.
	M.N.S. Swamy, Ph.D. (Saskatchewan)	Graph Theory, Signal Processing Networks and Systems Theory.

TYPICAL PROJECTS: Optimal planar circuit layout; time-table and task scheduling; travelling salesman and routing problems; assembly-line balancing; topological design of computer networks; flow control problems in computer networks; probabilistic methods for reliability estimations for industrial machinery and production lines; failure forecasts for equipment and operation.

COMPUTER AIDED DESIGN, MANUFACTURING AND ROBOTICS

DESCRIPTION: CAD/CAM and Robotics is a developing area in Mechanical Engineering which deals with the use of micro-,mini- and large computers in the analysis, design and optimization of mechanical components and systems for application.

SCOPE OF WORK: Research, development, automated design, automated manufacturing, robotics and manipulators, vehicle design, simulation of industrial products.

FACILITIES: A dedicated VAX 11/780 computer with 512KB of core memory, two cartridge disk curves (28 MB each), and an additional Winchester disk drive of 675 MB; a Kennedy 800/1600 BPI magnetic tape drive and a NORPAK/VDP high performance, raster scan color video graphic system; a CALCOMP model 1012, 12" drum plotter; a tektronix model 4663, flat bed plotter; and several CRT's.

FACULTY:

S. Sankar, D. Eng. (Sir George Williams)	Computer Aided Design of Mechanical Systems, Dynamic Graphics in Vehicle Design, Optimal Design.
R.M.H. Cheng, Ph.D. (Birmingham, U.K.)	Computer Aided Design of Fluid Systems, Automation, Robotics.
V. Latinovic, D.Eng. (Concordia)	Computer Aided Manufacturing, Production Technology, Graphics.
Y. Stepanenko, Ph.D. (Moscow)	Robotics and Manipulators, Simulation Methodologies.

TYPICAL PROJECTS: Some specific research areas are:

(i) Computer aided optimal design of transporation systems with reference to vehicle suspension performance.
(ii) Finite element analysis and dynamic graphics in the design of off-road vehicle structures.
(iii) CAD of sequential circuits for industrial processes.
(iv) CAD of complex mechanical systems through interactive graphics and analysis.
(v) CAD of rotor-bearing systems.
(vi) CAD of pneumatic stepper motors and circuits.
(vii) CAD of fiberglass reinforced plastic pressure vessels.
(viii) CAD of industrial robots.
(x) Computer controled compliance robots.
(xi) CAD scheduling, automated tolerancing.